Health Consultation

Radiological Contamination In Air Associated with Eastern Michaud Flats Contamination Pocatello, Bannock County, Idaho

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Division of Health Assessment and Consultation
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BACKGROUND AND STATEMENT OF ISSUES

In a previous public health consultation [1], the Agency for Toxic Substances and Disease Registry addressed concerns raised by members of the Shoshone-Bannock Tribes and residents of Chubbuck and Pocatello, Idaho, that operations at two phosphate processing facilities might lead to unhealthy levels of air pollution. To address those concerns, the previous document identified specific pollutants released to the air from these facilities, summarized air sampling studies conducted in the vicinity of the facilities, and evaluated whether the air sampling results indicated a public health hazard. This document addresses the impact on public health as a result of radiological contaminants released to the air from the phosphate plants.

The FMC Corporation (FMC) and J.R. Simplot Company (Simplot) operate phosphate processing plants that are located on what the U.S. Environmental Protection Agency (EPA) has designated the Eastern Michaud Flats (EMF) National Priorities List (NPL) site. Members of the Shoshone-Bannock Tribes and residents of Chubbuck and Pocatello have expressed concern regarding the occurrence of asthma and upper respiratory infections in their communities and childhood leukemia. Some community members believe these health effects are related to exposure to air pollutants emanating from FMC and Simplot. The Shoshone-Bannock Tribes have expressed additional health concerns, including concerns regarding congenital heart problems, heart problems among the elderly, and cancer [1].

This consultation reviews and discusses the radiological implications of air releases from both the FMC and Simplot operations. The information reviewed was obtained from several sources included the EPA, the Department of Energy (DOE), the state of Idaho, Idaho State University (ISU) acting as a consultation group to the Shoshone-Bannock Tribes, and remedial investigation (RI) and feasibility study (FS) documents prepared as part of the Comprehensive Environmental Response, Compensation, and Liability Act, (Superfund) requirements.

The nearest major population areas, the cities of Pocatello and Chubbuck, Idaho, to the phosphorous processing facilities are located east-southeast and east-northeast, respectively, of the FMC and Simplot facilities (see Figure 1). The facilities are about 2.5 miles from populated areas of these cities, but some residences are located closer to the facilities. No residences were observed within approximately 0.5 miles of either facility. As Figure 1 shows, the nearest populated area on the Fort Hall Indian Reservation—the Fort Hall Agency—is located about 8 miles north-northeast of the facilities. ATSDR notes, however, that the majority of the population on the Fort Hall Indian Reservation lives in rural areas, including some in proximity to FMC and Simplot [1].

The FMC phosphorous production facility covers an estimated 1,189 acres, almost all of which lie within the Fort Hall Indian Reservation. The Simplot facility (described below) is located directly east of the FMC facility. The FMC facility has produced phosphorous since 1949; some of the facility's processes have changed little since then. FMC has always produced phosphorous from phosphorous-bearing shale, which is shipped to the facility via rail car during the summer months and stored on site in large stockpiles. After passing through several mechanical processes (e.g., crushing), the phosphate rock is fed to calciners, which remove moisture from the feed. A mixture of this intermediate product, coke, and silica are then further processed in one of the facility's four electric arc furnaces. Outputs from the furnaces include gaseous elemental

phosphorus, various gaseous by-products (some of which contain radiological components), and solid wastes called "slag" and "ferrophos." The elemental phosphorus is subsequently condensed and eventually shipped off site, and the solid wastes are disposed of at various on-site and off-site locations. Though effluents from the calciners and electric arc furnaces pass through air pollution control devices, these operations emit a wide range of air pollutants, as do numerous other sources throughout the facility [1].

The Simplot Don Plant covers about 745 acres, none of which are on reservation property. As noted above, the Simplot facility adjoins the eastern property boundary of the FMC facility. Since 1944, the Simplot facility has produced various phosphorous-containing products; currently, the facility produces 12 principal products, including phosphoric acid, five grades of solid fertilizers, and four grades of liquid fertilizers. Phosphate ore is one of the principal feeds to Simplot's processes. Prior to September, 1991, the Simplot facility received its ore from mines via rail car. Since then, however, the facility has received its ore through a slurry pipeline. The incoming slurry then passes through various processes, depending on the product being made. Many of the products also use sulfuric acid as a feed, which Simplot manufactures on site. Like the processes at FMC, the processes at Simplot emit contaminants to the air and generate many forms of solid and liquid waste. Air pollution control devices at the Simplot facility help minimize adverse impacts on local air quality, but the facility has emitted, and continues to emit, a wide range of contaminants to the air [1].

In addition to owning the land on which the facilities operate, FMC and Simplot also own all land (with the exception of road rights-of-way) between the facilities and Interstate 86, as well as substantial property located immediately north of Interstate 86 and east of the facilities. Other land uses in the area include a dragstrip located across the access road from FMC, which has recently closed, and a softball field across the street from Simplot. Until March 12, 1995, the Bannock Paving Company (BAPCO) operated a paving and aggregate handling facility on land leased from, and adjacent to, the FMC facility. BAPCO periodically conducted many industrial operations at this site, such as processing asphalt, drying coke, and crushing slag and ferrophos [2].

The plants operate under different processes. The FMC plant uses a thermal process to produce elemental phosphorus [3]; whereas, the J.R. Simplot facility uses a wet process to produce phosphoric acid [4]. Both processes release radiological materials as byproducts to the environment. The radiological materials released include thorium 232 (Th 232), radium 226 (Ra 226), uranium isotopes (U 238, U 235, and U 234), polonium 210 (Po 210), lead 210 (Pb 210), radon 222 (Rn 222), and other components of the natural decay scheme for which the uranium or Th 232 is the initial source.

Because of the public health concerns, air modeling and sampling have been performed, data collected, and these impacts on the surrounding environment have been evaluated. For radionuclide analysis, the modeling activity collected samples from 7 locations.

According to the RI the EMF NPL site (referred to "the EMF study area" in the RI) includes land belonging to the Fort Hall Indian Reservation, the Bureau of Land Management (BLM),

Bannock and Power Counties, and portions of the cities of Pocatello and Chubbuck. Land use on the Fort Hall Indian Reservation in the EMF study area is mainly agricultural with scattered residences. BLM land is designated as multiple use. Unincorporated land in Bannock and Power Counties is mostly agricultural, also with scattered residences, and land within the cities of Pocatello and Chubbuck in the EMF study area is primarily zoned for residential use.

The area within a 1-mile radius of the FMC and Simplot facilities is sparsely populated, as is typical of areas with primarily agricultural and industrial land uses. However, the area within a 5-mile radius of the facilities includes much of the cities of Chubbuck and Pocatello, as well as a larger portion of the Fort Hall Indian Reservation. In summary, the area within 5 miles of the facilities is considerably more populated than the area within just 1 mile of the facilities.

For the purposes of regulatory control, the EPA established the National Emissions Standards for Hazardous Air Pollutants (NESHAPS). Under NESHAPS, the radiological dose to the entire body (the effective dose) is not to exceed 10 millirem per year. For phosphate type plants such as those at EMF, the regulations are codified at 40 CFR 61, subpart K and subpart R. Subpart K protects the public and the environment from the hazards of emissions of Po 210 and Pb 210 to the ambient air from phosphorus plants. Exposure comes from inhaling the radionuclides, with the lungs receiving virtually all of the dose, causing an increased risk of lung cancer. Accordingly, the EPA has regulated the total amount of Po 210 that can be released from phosphorus plants to 21 Ci/year and, through its control measures, also limit the emission of Pb 210. Subpart R protects the public and the environment from the radiological materials, specifically radium, radon, and uranium materials in the phosphogypsum materials. Subpart R regulates the concentration of radium in the phosphogypsum but not the amount of radionuclides released to the air.

Data collected by ISU included the collection of air filters initially used for PM_{10} analysis. ISU then determined the gross alpha radiation measurements and Po 210 concentrations in an attempt to correlate the gross alpha radiation with the concentration of Po 210 [5].

DISCUSSION

For a discussion of the non-radiological contamination released to air in and around the EMF NPL site, please refer to the ATSDR document previously referenced [1].

Environmental Contamination and Exposure Pathways

ATSDR reviewed radiological air data collected in and around the Eastern Michaud Flats area. Data in these reports covered radiological releases from the FMC and Simplot plant operations as well as data associated with environmental levels of radioactivity. As part of this review, ATSDR evaluated the air exposure pathway for the area. An environmental exposure pathway consists of five elements: (1) a source of contamination; (2) an environmental medium in which the contaminants may be present or into which it may migrate; (3) points of human exposure; (4) routes of human exposure, such as inhalation, ingestion or dermal absorption; and (5) a receptor population. A completed exposure pathway exists in the past, present, or future if all five of the elements of an exposure pathway link the contaminant source to a receptor population. A potential exposure pathway exists if there are insufficient data for one or more of the five elements linking the source of the contamination to the receptor population or if modeling replaces sampling data. A pathway can be eliminated if one or more of the five elements do not exist or the pathway is unlikely to occur. A future completed exposure pathway occurs when the contamination at a point of exposure exists and that contamination would expose a receptor population if the population were present. Future potential pathways exist if the contamination does not currently exist at a point of exposure but might migrate to some point of exposure.

When radioactive materials decay, air, water, and solid materials can transmit the decay products. During the transmission, the decay products interact with matter through a variety of processes, depositing energy in the system where the interaction occurs. If the interaction results in the alteration of the atomic charge, the radiation is called ionizing radiation. Because ionizing radiation is not a substance in the classical toxicological sense, it is considered not necessarily a contaminant but a type of electromagnetic or particulate energy. It is energy deposited within the system because of the interactions that result in the dose and ultimately the health effects. However, the radioisotope releasing the ionizing radiation is considered a contaminant.

The fact that completed air exposure pathway exist at Eastern Michaud Flats, does not necessarily suggest the a likelihood for adverse health effects. The evaluation of the exposure pathways with respect to health effects appears in a subsequent section of this public health consultation.

Because of the nature of plant operations, possible radionuclide releases include both volatilizing Po 210 and Pb 210 from the FMC calciners as result of heating ores, Rn 222 from the Simplot phosphogypsum stacks and other uranium series radionuclides. Ore used at both facilities contains 20 to 200 parts per million of uranium series radionuclides. At the Simplot facility, selective separation and concentration of radionuclides occurs. Uranium is concentrated in the phosphoric acid (86% separation) and Ra 226 is concentrated (80%) in the phosphogypsum [6]. In general, the radionuclide dispersions are similar to the particulate dispersions and the

monitoring stations selected for the determinations of particulate and other air pollutants are believed to be adequate for the analysis of radiological parameters [1, 6].

The majority of the data used in this document were derived from a 7 station air monitoring network running from October through December 1993 [7]. This network measured both PM_{10} (particulates smaller than 10 microns) and radionuclide concentrations. Generally, Po 210 and the uranium radionuclides (U 234/235/238) showed good correlation with the PM_{10} values. Furthermore, the data suggest there may be good correlation between particulate matter and Po 210, Th 230, and U isotopes in ambient downwind air. Pb 210, however, does not appear to be associated with particulate matter in ambient air within the EMF study area [7]. The reason for this is unclear because the decay of Pb 210 produces bismuth 210 which decays into Po 210.

Air filters used to measure particulates in the air (PM_{10}) were also analyzed for radionuclides. Of the radionuclides detected, only two filters exceeded the PM_{10} levels on a regular basis (more than 50% of the time, maximum value listed): Po 210 (0.35 pCi/m^3)[1] and U 238 (9×10^{-4} pCi/m^3). Only one analysis for Th 232 was elevated and 2 samples analyzed for Ra 228 were elevated (these may be artifacts of the measurement data as the dates do not match with the elevated Th 232 data). The data also indicated that downwind and during low wind events, the Pb 210 activity was 0.085 pCi/m^3 and during high wind, 0.055 pCi/m^3; only one value for Ra 226 was reported during downwind low wind events 0.0009 pCi/m^3; Th 232 downwind and during high winds was 0.00022 pCi/m^3; and U 234 was reported at less than 0.0006 pCi/m^3 [7].

At each sampling location, three samples also were collected using low volume air samplers. Low volume air samplers generally are used to collect long term air samples; however, the disadvantage is that any elevated release might not be observed over the period of a month. Although of questionable use because of the low number of samples, the following radionuclides (values derived from graphs) were detected: 1) Po 210 ranging from 0.005 to 0.024 pCi/m^3; 2) Th 230 ranging from 0.00017 to 0.00022 pCi/m^3 and; 3) U 238 ranging from 0.00006 to 0.00015 pCi/m^3 [6]. During the sampling period (October 1993 through December 1993), the monthly concentration each of the reported radionuclides was relatively constant at each site [7].

In a 1996 report [2], Bechtel reported on the air quality at the Eastern Michaud Flats study area. The results of the Bechtel radionuclide analyses are given in Table I. Also included in Table I are the derived air concentrations (DAC) for workers[2]. The DAC regulatory limits of the Nuclear Regulatory Commission (NRC) for air releases impacting the public also are supplied. Because the public exposure limits are different than that of workers, the DAC values are different. Neither the FMC nor the Simplot facility are required to be licensed by the NRC; therefore, the regulatory numbers are supplied as a reference point. The background values given in Table I were collected near the Pocatello airport.

The data reviewed by ISU included air samples collected from three locations identified as Michaud, Primary, and Sho-Ban. The air samples were analyzed for gross alpha radiation and then were evaluated for Po 210 based on the gross alpha radiation. ISU determined and after

ATSDR review of those data, that the gross alpha radiation could serve as an indication of Po 210 in the air around EMF. Of the 123 samples reviewed by ISU, duplicate analysis of 12 samples were reported. Duplicates can be used as in internal check of the data quality. Of the 12 duplicate samples; however, only 6 samples were analyzed for Po 210. In those samples, the range of Po 210 was 0.05 pCi/m^3 to 0.34 pCi/m^3. Because the results of the duplicate samples were very similar, this indicates that the analysis for samples in which duplicates were not analyzed could be used for comparison purposes. The highest concentration of Po 210 reported was about 0.43 pCi/m^3 and the NRC limit for public exposure is 0.9 pCi/m^3. For the filters collected from the Sho-Ban sampling points that were analyzed for gross alpha radiation, the results showed that the gross alpha concentrations ranged from background to 0.22 pCi/m^3. The corresponding Po 210 concentrations ranged as high as 0.18 pCi/m^3 [5].

The data from the Sho-Ban sampling points show that these locations have been impacted by releases from EMF; however, the levels are less than current regulatory limits. What is not known is how much higher the contaminations could have been during previous operations.

Based on this analysis, ATSDR believes the data collected during this specific time frame, October to December 1993, are adequate to evaluate the air quality for the purposes of public health to those individuals living near the Eastern Michaud Flats area.

Radiological Dose and Health Issues

The health risk associated with human exposure to airborne contaminants is a function of the concentration of the contaminants, duration of exposure, and inhalation rate. The radiological dose delivered to target organs (including the lungs) is dependent on the chemical forms, solubility and the internal dose. In the case of the radionuclides released at the EMF site, ATSDR believes the organs most likely impacted by these air releases are the lungs, the bone red marrow where the majority of the blood cell production occurs or perhaps bone surfaces[3].

Table I. Radionuclides detected in air samples collected in the vicinity of EMF.

Radioisotope	Site-Related Background Concentration* (pCi/m^3)	Range of detected contaminants related to Eastern Michaud Flats (pCi/m^3)	Occupational exposure from Federal Guidance 11 †(pCi/m^3)‡	10 CFR 20 Public Limits
Uranium 238	8.7×10^{-6}	1×10^{-5} to 4.8×10^{-4}	20	3
Uranium 235	4.1×10^{-7}	5×10^{-7} to 1.9×10^{-5}	20	3
Uranium 234	9.3×10^{-6}	1.1×10^{-5} to 4.0×10^{-4}	20	3
Thorium 230	3.5×10^{-5} (DL)§	ND to 2.85×10^{-4}	3	0.02
Radium 226	5.31×10^{-4} (DL)	ND to 5.4×10^{-4}	300	0.9

Polonium 210	4.4×10^{-3}	6.7×10^{-3} to 6.9×10^{-2}	300	0.9
Lead 210	1.7×10^{-2}	2.1 to 2.5×10^{-2}	100	0.6
Thorium 232	4.1×10^{-5}	ND	0.5	0.004
Radium 228	1.97×10^{-3}	ND	500	2

* Data from Remedial Investigation Report for the Eastern Michaud Flats Site. Part II. Air Quality characterization. Air Monitoring Report. Volume II, sections 1 to 6. August 1996. Bechtel.

† The amount of a radionuclide in air that if inhaled over a period of one year would impart a dose of 5 rem to a worker as discussed in Federal Guidance Report No. 11 [8].

‡ The amount of a radionuclide in air that if inhaled over a period of one year would impart a dose of 50 millirem as discussed in the Nuclear Regulatory Commission regulation, 10 CFR 20, Standards for protection against radiation.

§ Detection Limit - the instrument detection limit is the lowest value the monitoring equipment could detect.

To estimate the radiological dose, ATSDR used the radiological dose conversion factors supplied by the International Commission on Radiological Protection (ICRP) in Report 71 [9] and Report 72 [10]. For inhalation parameters, ATSDR used values supplied in the EPA Exposure Factors Handbook [11]. Using this information, ATSDR calculated estimated radiological doses to the lung, the entire body (called effective dose)[4], and either bone surfaces or the bone red marrow. The results of these calculations are supplied in Table II.

Table II. Estimated Radiological doses to organs of concern*.

Organ	1 Year old Child†	Adult
Bone Surface	22 millirem	48 millirem
Bone Red Marrow	7	5
Lungs	109	75
Whole body (effective)	12	10

*The calculated dose, expressed in millirem and rounded to the next whole number, is the total from all radionuclides listed in Table II. The dose was derived by converting the values given in Table I to millirem per year. Breathing patterns used are those derived from the EPA Exposure Factors Handbook (reference 11). The dose conversion factors were derived from the International Commission on Radiological Protection [10].
†Age at Intake

DISCUSSION OF THE REVIEWED DATA

Based on the information reviewed, Agency for Toxic Substances and Disease Registry (ATSDR) has affirmed that the FMC and Simplot facilities release radioactive material into the ambient atmosphere. The amounts of radioactivity released, however, did not exceed any federal standard for releases during that time period. The standards reviewed included both occupational standards and standards for the public.

ATSDR also performed a series of dose calculations based on the supplied data. These calculations, using the most conservative (highest) values, were performed for those organs deemed most important based on community concerns previously determined by ATSDR [1]. Our radiological review indicates that the facilities at EMF are within regulatory compliance as the radiation dose to the whole body does not exceed the 10 millirem dose limit (Table III).

The associated health effects resulting from these exposures, however, is more difficult to determine. The major reason is that the accumulated doses are not much different than the doses one might accumulate just by moving to different parts of the country. In the case of radiation induced bone cancer following the intake of radioactive material similar in nature to the materials released from EMF (alpha particle emitting radionuclides), and using estimates from the National Research Council [12], the radiological dose to the bone resulting from air emissions at EMF are not expected to result in any adverse bone cancers.

Radiation dose delivered to the bone marrow could result in several blood-related illnesses such as myeloid and lymphatic leukemia [12] that may be age-related [13]. Although there is much information regarding induction of leukemia following external exposure to ionizing radiation [12], little information exists relating the intake of radioactive materials and the induction of leukemia other than information related to ingestion of radium by the radium dial painters. Studies of the dial painters reviewed by Rowland showed that leukemias did appear shortly after exposure; however, the data appear to be inconclusive [14]. The synopsis of these studies also reported that the lowest dose estimated in the entire group dial painters was approximately 40 rem, about 5,800 times higher than the doses estimated around EMF.

Using these results as an indicator of effect, ATSDR believes it is unlikely that any adverse health effects related to blood-related illness would be expected in individuals living around the Eastern Michaud Flats site.

CONCLUSIONS AND RECOMMENDATIONS

Inhaled radioactive materials also affect the lungs. As with the case of other organs reviewed in this document, little is known about the risk factors associated with radiation induced lung cancer [12] associated with radiation doses in the environmental range. In most cases, what is known is related to the inhalation of radon and its decay products or the association of smoking with radon.

The estimated radiation dose to the lungs of residents around the EMF facility is on the order of 100 millirem per year. As a comparison, the average individual's whole body dose from the inhalation of radon gas is 200 millirem per year [15] with the majority of this dose being delivered directly to the lung and its associated structures (airways, deep lung tissue, etc.). Because the radiological dose to the lungs from releases related to EMF is similar to environmental levels, ATSDR does not believe any adverse health outcomes would be related to these radiation exposure or radiation dose levels.

Therefore, ATSDR has categorized the radiological emissions to the atmosphere during the period of time covered by the data reviewed as a no apparent public health concern. Because we do not have data for other periods of time, ATSDR is uncertain about exposures that could have resulted during those periods of time when air emissions were much different than those that currently exist.

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[1]The abbreviation pCi/m^3 represents the radioactivity in a volume, in this case air. The pCi represents a picocurie, an extremely small amount of radioactivity and the m^3 is a cubic meter. There are 264 gallons in a cubic meter.

[2]The DAC represent the amount of the particular radionuclide in air that if inhaled would result in a dose of 5 rem, the regulatory limit for workers at the time of these DAC publications (1988).

[3]For the purposes of radiation dose to the bone, some radionuclides are considered to be concentrated along the surface of the bone. Other radionuclides are considered being distributed throughout the entire bone (referred to as volume seeking) irradiating the red marrow.

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[4]The radiological dose is calculated by assuming an individual is inhaling air containing the reported concentration of radiological materials. The inhalation rates are those published by the EPA.

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